Managing uncertainty through RIIO-T2

Seeking your views on how we plan our business and manage uncertainty against a changing energy landscape

26th February 2019

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2 Introduction and background

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Introduction

Who we are

We are National Grid Electricity Transmission (NGET). We own and maintain the high-voltage electricity transmission network in England and Wales. We move electricity from where it's generated, down the 'motorway' of the electricity system, to the distribution network companies who deliver that power to homes and businesses.

Introduction

We are building a business plan, guided by our stakeholders, for the RIIO-T2 regulatory period which runs from 2021/22 to 2025/26.[1] We will submit this to our regulator, Ofgem, later this year.

The views of our stakeholders are important to us. This consultation is part of an extensive programme of engagement on our future business plan.

In this consultation, we are playing back what we have heard from our stakeholders on the future role of electricity transmission. We are also seeking your views on how we plan our business against an uncertain future and develop a price control that is sufficiently flexible to deal with uncertainty.

We welcome your views on our suggestions, and we will continue to develop them as we hear more from you. Your responses to this consultation will help inform our business plan in the areas of how we make it easy for our customers to connect to and use the electricity network and how we are looking to enable the ongoing transition to the energy system of the future.

Together, we will shape the electricity transmission system of tomorrow.

David Wright,
Director of Electricity Transmission

Consumer and stakeholder priorities

We've used your feedback to develop three consumer priority statements and eight stakeholder priorities that are are being used to structure our engagement activities and business plan. This consultation is focused on two of the eight priorities (shown in green).

Consumer priorities

I want an affordable energy bill	I want to use energy as and when I want	I want a sustainable energy system

Delivered through stakeholder priorities

I want you to provide a safe and reliable network, so that electricity is there whenever I need it	I want your network to be protected from external threats	I want you to care for communities and the environment	I want you to be transparent
I want you to make it easy for me to connect to and use the electricity network	I want you to enable the ongoing transition towards the energy system of the future	I want you to be innovative	I want you to provide value for money

Key priorities in context of this consultation on dealing with future uncertainty

How you can respond to this consultation

This consultation is aimed at all users of our network, government, regulatory bodies and energy industry professionals. We also welcome responses from anybody who is interested in the future of electricity transmission. Simply send your views to gary.stokes@nationalgrid.com by 1 April 2019.

Find out more

You can learn more about how we are working with stakeholders by visiting our website. The site makes it easy to follow our progress as we work collectively to shape our RIIO-T2 plans – and shows you how to get involved.

[1] RIIO-T2 is a five-year programme which sets NGET's business plans, revenues and outcomes. RIIO standard for Revenue = Incentives + Innovation + Output, and T2 stands for the second transmission price control under the RIIO framework.

External context

The changing energy landscape in which we operate

The electricity industry has made considerable progress in reducing its environmental impact. At the same time, supply is becoming more diverse, and demand more flexible, than ever before. As such, the electricity system has a significant opportunity to play a key role in decarbonising other sectors of the economy, such as transport and heat.

As the electricity transmission owner in England and Wales, we sit at the heart of the nation's energy system. We are working with our stakeholders to address the challenges arising from this change to maximise the benefits for consumers and society overall.

Three main trends

The way energy is generated, transported and consumed is changing, characterised by three main trends – decarbonisation, decentralisation and digitalisation. These are explained in the boxes to the right. The size and pace of these trends is uncertain.

Drivers behind this change

In our consultation on the Future of Electricity Transmission in September 2018, we identified the main drivers behind these trends as (i) government policy, (ii) a rapid reduction in the cost of distributed energy, (iii) changes in consumer behaviour and (iv) advances in digital technology.

Consequences of external environment for our future plans

The business plan we submit this year will reflect the changing external landscape and take account of issues such as:

- the active role demand can play in solving network issues;
- the increasing need to work across organisations to deliver the best outcomes for consumers; and
- the **increased uncertainty of future supply and demand**.

The three main trends explained

Decarbonisation

Britain's electricity system is changing at a rapid pace as we move towards a low-carbon future. This transition to a low-carbon future has been led by the electricity sector, having achieved a 60% reduction in greenhouse gas emissions in the past four years alone.

Since 2011, around 15 GW of fossil-fuel-powered generators have closed and been disconnected from the system. This has largely been driven by government decarbonisation policies.

Looking to the future, the electricity system is likely to continue playing a substantial role in decarbonising both transport and potentially heat. However, exactly how that will happen, the magnitude, and the speed in which it will occur, remain uncertain.

Decentralisation

Traditionally, electricity flowed from large generators, connected to the transmission system, through passive distribution networks to the consumer.

Technology has advanced, particularly in the areas of smaller generation such as solar and small-scale wind farms, and storage. This has created significant changes in supply and demand patterns.

Distribution System Operators are emerging; playing a more active role in managing supply and demand because larger amounts of electricity are being produced closer to where it is consumed. This in turn affects the flows and the investment / operational requirements on the transmission network.

Digitalisation

The world is becoming increasingly connected. This is empowering consumers and disrupting traditional business models across almost every sector.

In energy, we are seeing new businesses capitalise on a plethora of new technologies from smart meters to the use of sensors, data collection and analytics (otherwise known as the internet of things).

These new business models have the potential to transform how we consume electricity. This will increase both the flexibility and volatility of demand.

Our approach to managing uncertainty through business planning and RIIO-T2

Overview

Increased uncertainty of future supply and demand is one of the consequences of the changing energy landscape. As highlighted in the *External context* section, the energy industry is already undergoing a transition. Cross sector and individual business processes have to evolve to continue delivering for consumers.

This also applies in the context of electricity transmission networks. Some changes to ongoing processes have already occurred (such as the introduction of the Electricity System Operator's Network Options Assessment). New challenges have also arisen in **business planning** over different timescales, against a wide envelope of future energy scenarios and ensuring the next iteration of **RIIO price controls** is flexible enough to deal with uncertainty.

1) Approach to business planning

Given the ongoing changes in the energy sector, the long-term need for electricity transmission is an emerging question. Based on our engagements with stakeholders, we have begun preparing our plans for RIIO-T2, where we would need to deliver against a range of future energy scenarios.

2) Approach to setting the RIIO-T2 price control

There is a need to evolve the suite of load-related (i.e. supply and demand driven) uncertainty mechanisms we developed for RIIO-T1 to deal with the added uncertainty of the changing external landscape.

These mechanisms have adjusted our revenue by over £2bn from the baseline allowance in RIIO-T1. A more conservative baseline may be more appropriate for T2.

Your views will help us ensure both our business plan and the price control are robust to future uncertainty

Area of Impact	Timescale	Aspect of managing uncertainty	Focus of this document	
1) Business planning	**Long term** *(significant uncertainty beyond 2030)*	• The need for and role of electricity transmission networks **beyond the T2 period**	i. **Playback of what you have told us** through our engagement activities in August, September and October 2018	We discuss this further in **Chapter 3**
	Medium term *(range of possible futures up to 2030 including the RIIO-T2 period)*	• The **approach to business planning** for the future	ii. **Introducing our approach** to business planning	
		• The **range of possible future scenarios** NGET should plan against	iii. **Seeking your views** on the range of futures we are planning against	
2) Setting the RIIO-T2 price control		• Setting a **baseline allowance** for T2 expenditure against which uncertainty mechanisms will operate	iv. **Seeking your views** on developing a single scenario used to set a baseline revenue allowance	We discuss this further in **Chapter 4**
		• Appropriate **uncertainty mechanisms** that adjust the baseline allowance based on what actually needs to be delivered	v. **Seeking your views** on our proposed approach to uncertainty mechanisms in the T2 period	

3 Business planning for the future

i. Playback of engagement on the long-term future of electricity transmission

ii. Our approach to business planning

iii. The range of energy futures for business planning

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i. Long-term future of electricity transmission

Our Future of Electricity Transmission consultation

Our approach to thinking about long-term uncertainty

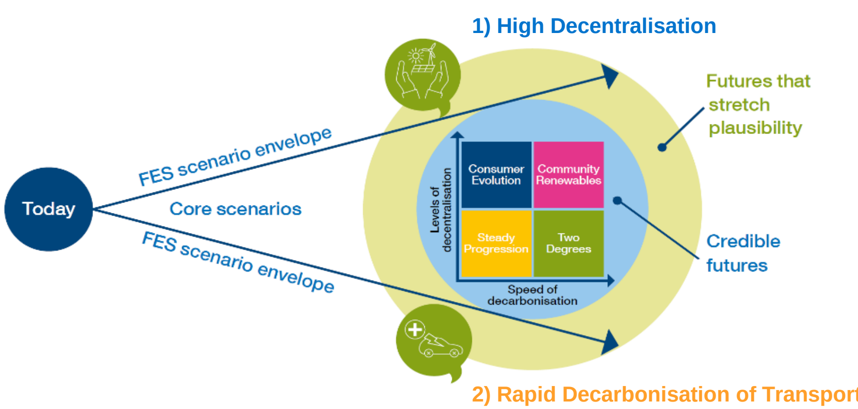
The use of scenarios that set out a range of credible futures is a common strategic tool for thinking about future uncertainty. The annual Future Energy Scenarios (FES)[1] are integral to existing processes that make decisions in the short to medium term as well as the starting point for our longer-term thinking.

To ensure that processes already in place to manage uncertainty in the short to medium term are robust, we have developed two additional sensitivities on the long-term role of transmission. These sensitivities stretch plausibility beyond the core FES envelope to stress test the industry trends most likely to impact the role of electricity transmission in future:

(1) High Decentralisation.

(2) Rapid Decarbonisation of Transport.

Our approach is summarised in the diagram below.



We undertook detailed modelling and analysis of the sensitivities to explore three key questions (shown right). The detail of our approach and outcomes are published in a discussion document.

[1] The FES are produced by the Electricity System Operator in conjunction with stakeholders

Key questions and conclusions from our analysis

1 Is an electricity transmission network needed in a highly decentralised world?	2 Could the current transmission network be a blocker to rapid growth in electric vehicles?	3 How does the transmission network need to evolve to facilitate the energy transition?
Despite uncertainty the continuing need for a transmission network is evident	**The Transmission network will not be a barrier for rapid growth in electric vehicles**	**Whole system thinking and cross vector operability are essential to ensure a least cost transition to a low carbon world**
The transmission network is required to provide cost effective access for large capacity generation, increased interconnection and the continued decarbonisation of supply	The electricity transmission network will not be a barrier for a rapid decarbonisation of transport	The diverse geographic location and variability of supply sources and new points of connection are creating new operability challenges when managing the network
The bulk power transfer capability of transmission will still be needed to ensure consumers can access the cheapest sources of electricity at all times		The electricity transmission network is an important tool, in a range of solutions, to manage operability challenges in the most cost effective way for consumers
Areas of regional energy surplus and deficit are likely to remain. The transmission network will be needed to ensure electricity is there when consumers want it		Whole system thinking and cross vector operability are essential to ensure a least cost transition to a low carbon world; doing nothing is unlikely to be in consumers' interests
		Given the level of uncertainty around future pathways and relative low cost of maintenance, it is in consumers' interests to leave the option of existing infrastructure open

i. Long-term future of electricity transmission

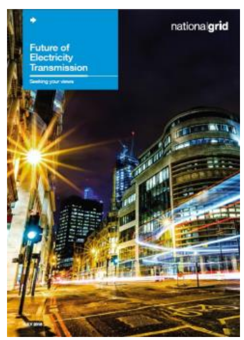
What you told us on the future of electricity transmission

Engagement approach

In engaging on the future of electricity transmission **our aim** was to (i) inform stakeholders in an area with minimal analysis and debate in the public domain and (ii) gather stakeholder views on their priorities and the future role of electricity transmission in order to shape our engagement plans and approach to dealing with uncertainty.

The discussion document published in July 2018, described on the previous page, was used as the basis for a number of direct engagements **through multiple channels**, such as blog posts, an online survey, webinar, bespoke sessions and bilateral discussions over the course of August and September of 2018, as detailed below:

- **Blog post** on how electricity transmission has benefitted consumers in the past, published 24th July
- Full version of our **discussion document**, published 27th July
- Presentation to independently chaired **User Group** 31st July
- **Webinar** held on 15th Aug.
- **Blog post** on role of electricity transmission in a decentralised future, published 15th Aug.
- **Session with BEIS** Electricity Strategy, Networks and Markets team 19th September
- **Session with Ofgem** price control team 26th Sept.
- **Session at Association for Decentralised Energy** 26th Sept.
- Engagement approach on Future of Electricity Transmission reviewed by independently chaired **User Group** 3rd Oct.
- Ongoing bilateral discussions with Distribution Network Owners and through the Energy Networks Association



Engagement outcomes

We **engaged with over 70 different stakeholders across 37 organisations**; representing academics, consumer bodies, regulators, large customers, small customers, network companies, the supply chain, governmental and special interest groups.

Sample of stakeholders engaged:

Through engagements on this topic, we asked stakeholders about (1) their energy priorities for the next decade, (2) the trends we focussed on and (3) their views on the outcomes of our analysis.

Things stakeholders told us was a priority for them:

“
Adapt effectively to increasing renewables

Support for EV roll-out

To meet government targets more needs to be done

A totally reliable service

Engaging all consumers in the transition

Harnessing latent flexibility

Facilitating whole system outcomes

Enabling customer solutions

Security of supply

Predictability and transparency of charges
”

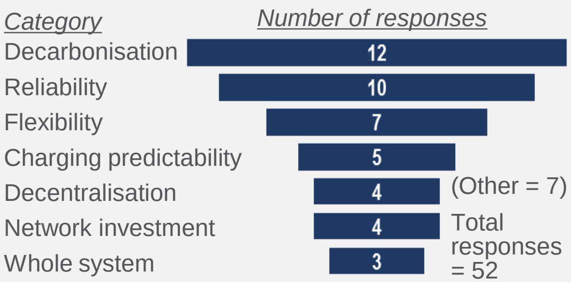
i. Long-term future of electricity transmission

How engagement outcomes on future of transmission have shaped our plans

1) Energy Priorities

To help shape our engagement approach and business plan focus we tested stakeholders' energy priorities[1]. When we asked about their energy priorities through a free text question and categorised responses, most stakeholders indicated that their **priorities are decarbonisation and reliability** related (22 out of 52). Detailed categorisation, below.

What are your energy priorities over the next decade?

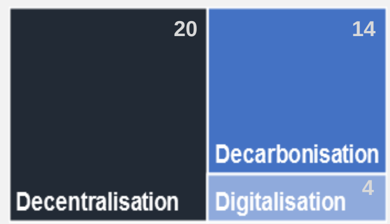


Conclusions: We will use insights from this engagement to focus what we propose to deliver within the stakeholder priorities we've already established (e.g. enabling customer solutions), to draw out how our RIIO-T2 plans address priorities (e.g. how we're facilitating flexibility) and to plan further engagement, focussed on these areas.

2) Trends in focus

We tested whether our focus on stretching the decentralisation and decarbonisation assumptions of the Future Energy Scenarios in our analysis was sufficient. The majority of respondents (34 our of 38) indicated through multiple choice that these focus areas are the trends most likely to impact the future role of electricity transmission.

Which of the macro trends do you think will have the biggest impact on the future role of electricity transmission? (no. of responses)



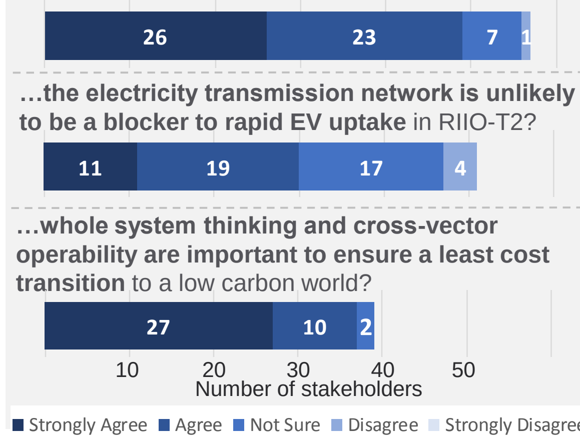
Conclusions: Stakeholders broadly agreed with our areas of focus. We will utilise the valuable insights gathered through analysis of futures that stretch the level of decentralisation and the speed of decarbonisation of transport (e.g. ensuring the network is resilient to rapid changes in demand) in building our plans.

3) Outcomes of analysis

We tested stakeholders views on the three primary conclusions of our analysis through multiple choice questions as set out, below.

What is your view of our conclusion that…

…despite uncertainty, **the need for the electricity transmission network in future is evident?**



Conclusions: Most stakeholders recognise the ongoing need for transmission despite uncertainty, allowing for planning to focus on RIIO-T2 timescales. Less agreed that the network would not be a blocker to EV uptake, so we will continue to engage heavily in this area. The need for a whole system approach was most positive; building our plan in this manner is important.

[1]Stakeholders' Electricity Transmission Priorities were established in April 2017 and documented in our 'Listen Report'

Seeking your views:

1. Have we captured your views correctly on the future of electricity transmission?
2. Is there anything else you would like to add to these views?

ii. Our approach to business planning

Overview of our business planning process

Overview

Planning the electricity transmission network to accommodate changes in supply and demand can be complex. This is because of:

- uncertainty on future electricity market conditions;
- the importance of whole-system thinking in finding solutions; and
- the large, long lead time nature of some network investments

A robust business planning process is required to ensure that the right investments are being delivered (at the right time and location) to maximise long-term value for consumers.

Business planning as part of the investment lifecycle

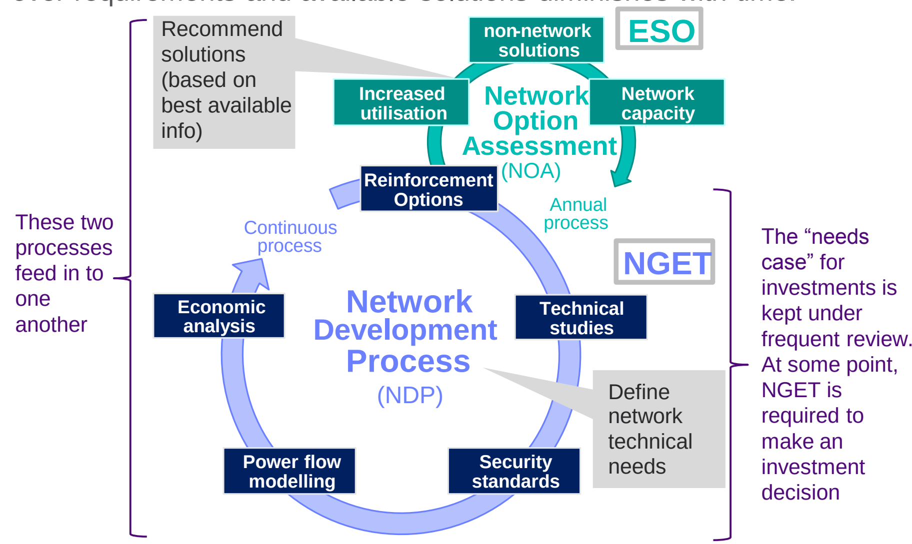
The figure below shows a typical investment lifecycle and our business planning process.

Starting point for planning	Scenario development	Development of NGET's view (England & Wales)	ESO Future Energy Scenarios process (Great Britain)
iterate			
Ongoing consideration of need, options and solutions	Establish requirements	Connection applications, assess compliance against security standards, etc	
	Identify system needs	Network Development Process (NGET)	Network Options Assessment (ESO)
	Identify options	ESO, NGET and DNO regional development planning process	
	Assess and select solution	Assessments run by all network owners and system operator with Ofgem oversight	
iterate			
Informs options and solution	Design and procure solution	Detailed design, benchmarking, cost-estimation and competitive procurement process	
	Deliver and operate solution	Regulatory incentives to innovate in delivery and operation; minimising costs	

Business planning is a consultative and iterative process

The business planning and investment lifecycle is based on a consultative and iterative process. It takes into account the costs and benefits of network investment, including the value of leaving options open based on the best available information at a given point in time. For example, this may help in cases where a little is spent now to mitigate the risk of larger costs in the future.

The figure below shows the Network Development Process and the Network Options Assessment led by NGET and the ESO respectively. These processes allow for decision-making to evolve as uncertainty over requirements and available solutions diminishes with time.



This process supports the managing of uncertainty over the short to medium term; new information from market developments and detailed design is suitably assessed to inform decisions.

The starting point for **forward-looking business planning in all businesses** is a view on the future (i.e. a scenario). This is discussed in the next page.

iii. Range of energy futures for business planning

Scenarios are a necessary starting point for forward-looking business plans

How scenarios are used for business planning

The development of scenarios is a necessary starting point for business and investment planning across all companies and sectors. Scenarios provide a view of the expected evolution of the market and are updated regularly.

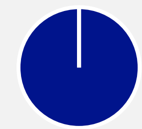
To accommodate a whole system planning approach and the long lead time of some investments in electricity networks, it is important to set a robust and credible view of how market conditions for generation and demand could evolve over time.

As such, scenarios serve as a key tool to **ensure our business is prepared to facilitate decarbonisation at lowest cost to consumers**. The development of scenarios would typically take into account market data, industry insight and stakeholder views.

Insights from initial engagements

In November 2018, we asked a small and varied set of stakeholders about the suitability of FES as a range of credible futures to plan our business against. All 14 responses considered FES to be suitable.

Are the Future Energy Scenarios (FES) a suitable range for planning NGET's business?



Through our bilateral engagements with all the Distribution Network Owners in September and October of 2018, many told us that their own regional, bottom-up forecasts or scenarios should be considered alongside their annual input into the FES process.

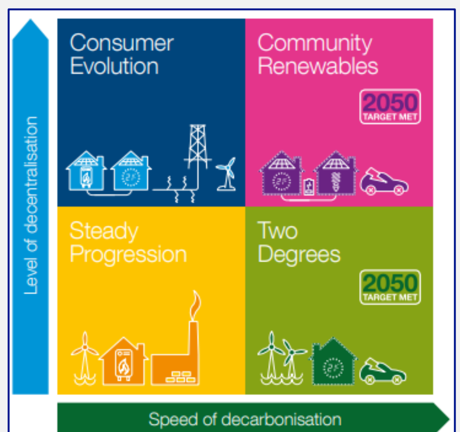
We propose to use the Future Energy Scenarios as the basis for our business planning, further informed by local insights

ESO gathers extensive stakeholder input

Sector	# Orgs.
Energy industry	187
Customers	77
Innovators	44
Academic	22
NGOs	21
Investors	19
Political	15
Small businesses	13
Supply chain	13
Media	8
Communities	6
Consumer groups	4
Regulators	1
Total	430

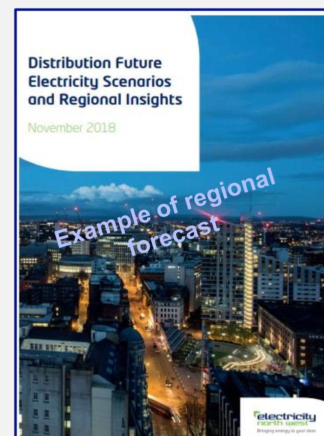
Source: ESO FES Stakeholder Feedback Document 2018

ESO annually create credible, national pathways for the future of energy over next 30+ years



Source: ESO Future Energy Scenarios 2018

Further informed by regional forecasts and other insights



Source: ENW Distribution Future Energy Scenarios 2018

iii. Range of energy futures for business planning

We propose to use the Future Energy Scenarios and regional insights

Future Energy Scenarios Overview (Great Britain)		2017	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Transport	Exceeds 2 million electric vehicles	95k					CR, TD					SP, CE	
	Exceeds 1 GW of vehicle-to-grid capacity	N/A											CR
Heating	10% of homes using low carbon heating									CR, TD			
Electricity Generation	25% electricity from distributed resources	17%			CR		TD		CE				
	Hits 60% renewable generation output	26%					TD	CR					SP
	Carbon intensity of electricity generation below 100g CO_2/kWh	266g CO_2/ kWh						TD	CR				
Electricity Storage	Exceeds 6 GW electricity storage technologies	2.9 GW						TD	CR			CE	
Electricity Interconnection	10GW of electricity import capacity	4 GW			TD	CR	SP	CE					

Scenarios Key

2050 targets ✓
- CR Community Renewables
- TD Two Degrees

2050 targets ×
- CE Consumer Evolution
- SP Steady Progression

Regional insights

Insights gathered from:
- NGET's local market intelligence
- Distribution Network Owner forecasts, scenarios and joint technical planning
- Other energy related, regional publications
- Analysis of trends and publicly available data

More detail of England and Wales Future Energy Scenarios provided in Section 4 and Appendix 2

Source: ESO FES in 5 minutes 2018 *Note: The location of each marker indicates when the relevant metric is achieved in each scenario*

Seeking your views: 3. Are the Future Energy Scenarios, further informed by regional insights, a suitable range for planning our business? If not, what else should we consider?

4 Managing uncertainty in setting the RIIO-T2 price control

iv. Developing a single scenario used to set a baseline revenue allowance

v. Our proposed approach to uncertainty mechanisms in the T2 period

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iv. Developing a single baseline scenario

A ‘whole system’ approach to developing a single baseline scenario

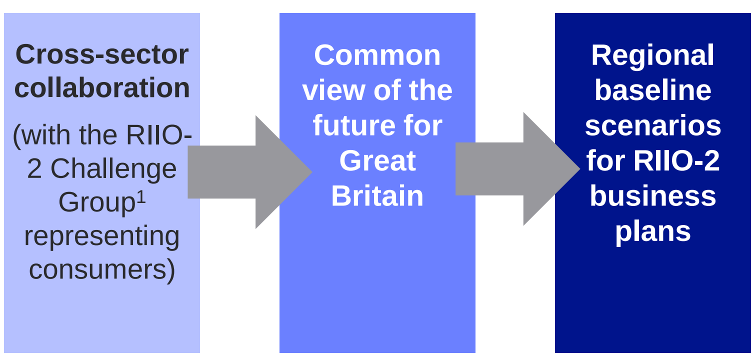
The need for a baseline scenario

A baseline scenario is a necessary starting point to develop a business plan that is flexible against a range of possible future outcomes. This represents a view of future market conditions which informs how the transmission network might need to operate in the future. In turn, it provides information on the timing, location and scale of investments required, and the funding needed to deliver them (subject to uncertainty mechanisms amending the baseline over time).

We are working with regulated gas and electricity networks to develop a ‘common view of the future’ across the whole energy system. This common view would form a baseline scenario for Great Britain.

The common scenario for Great Britain would then be used to develop more refined, specific **regional baseline scenarios.** The regional detail will be refined based on your views, ready for our RIIO-T2 business plan submission. Our business plan submission will propose an initial revenue allowance to deliver requirements against this baseline scenario for England & Wales (i.e. where we operate).

This will then be subject to iterations through our planning process described on page 11 and revenue adjusting uncertainty mechanisms described on pages 22 and 23.

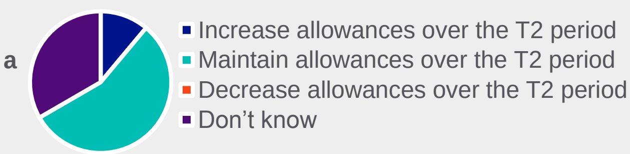


Principles for the development of a baseline scenario

It is paramount that NGET’s inputs supporting the development of both (i) the common view of the future for Great Britain and (ii) a regional baseline scenario, delivers the right consumer outcomes. To achieve, this we have been guided by several principles.

- **Credibility**: We have ensured that each assumption made is evidence-based and justified. Although uncertainty mechanisms will adjust the baseline, a credible scenario will minimise variations in allowances and customer charges (see response from a November 2018 presentation to 14 customers below).

Our baseline should be set in a manner that is most likely to…



- **Transparency:** We have sought to ensure that our process and assumptions are as transparent as possible through various stakeholder events and this consultation document. As such, we will also endeavour for a continuous iterative process with stakeholders over the next few months.
- **Collaboration:** Given the cross-sector impact, we recognise the importance of collaboration on areas that are more uncertain and have extensive reach (e.g. decarbonisation of heat and transport and the future of gas generation). This intends to promote a whole-systems view.
- **Conservative:** For drivers that are more uncertain, we have opted for a conservative view to avoid the potential inclusion of investments with an uncertain need in our baseline allowance.

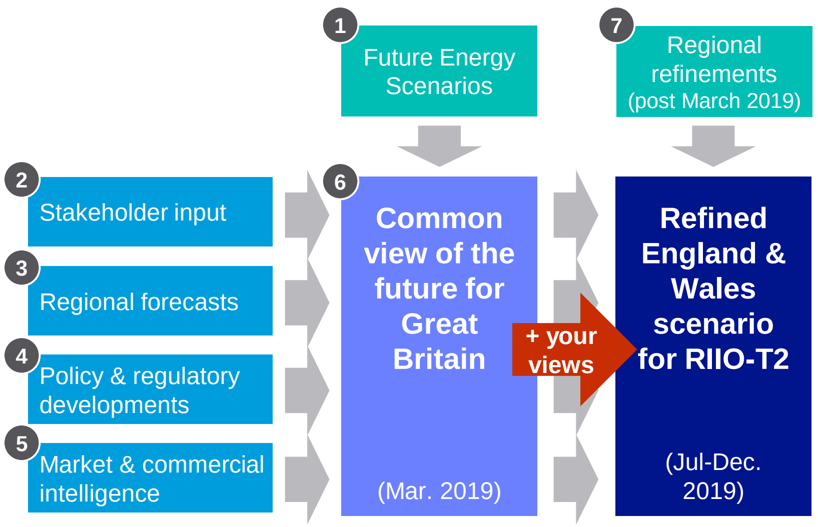
[1] The independently chaired, RIIO-2 Challenge Group has been set up by Ofgem to scrutinise company business plans and Ofgem’s decisions across RIIO-T2, RIIO-GD2 and RIIO-ED2

iv. Developing a single baseline scenario

Our approach to developing an England and Wales baseline scenario

Our approach to developing an England & Wales (E&W) specific baseline

The figure below sets out how we propose to develop an England & Wales baseline from the overarching common Great Britain scenario agreed across networks.



Stakeholder input, regional forecasts, policy & regulatory developments, and market & commercial intelligence are first used to develop the common view of the future for Great Britain, before continuing to refine the E&W scenario for RIIO-T2.

The rest of this document sets out our initial view of the E&W scenario which will be further refined by various inputs, including your views and our work with other networks, over the coming months.

1. **FES:** the FES scenarios form the 'starting point' for development of the common view of the future for GB and the E&W scenario. For the latter, we extract the England and Wales data from the FES and test each assumption when formulating our input.
2. **Stakeholder input:** provided from our various events and discussions since July 2018, including bilateral discussions with electricity distribution networks (see pages 9 and 10).
3. **Regional forecasts:** regional and local factors are taken into account with insights gained through regular and bespoke activities (see pages 12 and 13).
4. **Policy & regulatory developments:** we have endeavoured to capture the effects of recent policy/regulatory developments and changes to energy market arrangements (e.g. the (current) suspension of the Capacity Market).
5. **Market & commercial intelligence:** where relevant, we have used our in-house expertise on key drivers that could affect the system (e.g. recent uptake in commercial applications of transmission-connected battery storage).
6. **Common view of the future for GB:** a collaborative activity across regulated energy networks with more detail on this process in Appendix 1.
7. **Regional refinements post March 2019:** factors in any major developments post March 2019 and seeks to balance regional nuances with the need for a self-consistent GB scenario.

Seeking your views:

4. What are your views on our approach to developing an England & Wales baseline scenario for electricity transmission?
5. Should we aim to set a baseline for electricity transmission in England & Wales that is more likely to (i) increase, (ii) maintain or (iii) decrease revenue allowances via uncertainty mechanisms across the price control period?

iv. Developing a single baseline scenario

We test each FES assumption underpinning the key drivers for E&W

Key drivers

We set out the key drivers for the E&W scenario below. Our initial view of these key drivers are determined by testing each FES assumption (after isolating the E&W region only) against our initial assumptions (derived from stakeholders, regional insight and market & commercial intelligence).

1. Demand

"Base" demand drivers		"New" demand drivers	
Economic activity	Energy efficiency	Energy storage	Electric vehicles
Consumer behaviour	Industrial processes	Heat pumps	Demand-side response

- Understanding how electricity demand on the transmission network could evolve is a key determinant in informing the need for reinforcement over the RIIO-T2 period.
- We use four distinct variations of demand in this document.
  - **Underlying demand**: the measure of demand that reflects entire electricity consumption of end-users (including distributed generation and storage).
  - **Transmission demand**: the measure of demand that reflects demand on the transmission system only (underlying demand net of distributed generation and storage).
  - **Base demand**: the portion of demand driven by minimal changes to the existing technology stock (e.g. changes to economic activity and consumer behaviour).
  - **New demand**: the portion of demand driven by anticipated advancements technology and their subsequent rollout (e.g. storage, EVs and heat pumps).

2. Generation, interconnection and storage

Transmission connected		Distributed technologies	
Supply decline (e.g. coal, nuclear)	Interconnectors	Wind	Solar
Other connections	Asynchronous generation[2]	Diesel & Gas	Energy storage

- In parallel to the evolution of future demand, understanding how power generation, interconnection and electricity storage technologies are likely to evolve is a key determinant of the need for future reinforcements.
- Overall, considerable changes to the transmission network are expected over the next few years. While all coal plants are expected to decommission by 2025, new connections to interconnectors and asynchronous generation are likely to continue.
- On distributed generation and storage,[1] significant growth is expected. This affects both demand on the transmission network as well as transmission-connected technologies.
  - The growth in distributed generation is likely to have the largest impact on demand on the transmission system (as consumers receive power through the distribution network or self-generate);
  - Lower demand in the transmission system might also lead to lower required total capacity in transmission generation (not withstanding locational differences in GB as areas with high supply might have low demand and vice versa).

[1] We also include "behind-the-meter" generation and storage in this category.
[2] Asynchronous generation = wind, hydro, etc.

iv. Developing a single baseline scenario

Summary of how our key assumptions compare to the FES scenarios for E&W

Demand assumptions

Electricity demand assumptions are difficult to forecast over the long term relative to generation assumptions due to the significant uncertainty surrounding the timing and scale of the decarbonisation of transport and heat through the electricity system. Historically, industry forecasts have tended to be over-optimistic on when demand might experience a significant increase.

Given this uncertainty, we have made more cautious assumptions, especially over the RIIO-T2 period, on when the scenario would impact our initial baseline revenue allowance.

		Comparison with FES – Position	Comparison with FES – Closest scenario	Reason
Base + New	Transmission winter peak	In the middle of the FES scenarios	Close to TD	• Sustained low economic growth • Improvements in energy efficiency limited by financing • Electrification of heat and/or transport in the late 2020s (affecting underlying demand more than transmission demand)
Base + New	Underlying winter peak	Bottom end of the FES scenarios (until 2025)	Close to TD	
New	Storage	Higher than FES scenarios	Higher than TD CR	• Greater transmission connected storage (evidenced by internal commercial interest)
New	Electric vehicles	Top end of the FES scenarios (until 2025)	In line with TD CR	• In line with FES but slows down mid-late 2020s due a need for additional policy to fully meet targets.
New	Heat pumps	Top end of the FES scenarios (until 2025)	In line with TD CR	• Fast growth initially due to policy targeting off-gas grid homes. Slower growth in mid-late 2020s due to competing technologies.
New	DSR	In the middle of the FES scenarios	Between TD CR	• Similar technology uptake to Two Degrees but lower consumer engagement / response to time-of-use tariffs

Generation, interconnection and storage assumptions

Generation, interconnection and storage assumptions can be forecasted relatively well in the short-term based a combination of policy announcements and investment plans.

As such, we have used a combination of market & commercial intelligence (as well as recent stakeholder views) to refine several assumptions as presented in the FES.

		Comparison with FES – Position	Comparison with FES – Closest scenario	Reason
Transmission connected	Nuclear	In the middle of the FES scenarios	Below TD	• First unit of Hinkley Point C connecting in 2025/26, a conservatively optimistic view, based on progress to date
Transmission connected	CCGT	Close to the lowest FES scenario	Between TD CE	• Updated based on conservative market & commercial insight and the suspension of the Capacity Market
Transmission connected	Offshore wind	Close to the highest FES scenario	Close to TD	• Higher than FES based on reducing technology costs, the suspension of nuclear projects, and expected sector deal
Transmission connected	Inter-connector	Close to the highest FES scenario	Close to TD	• Number of new interconnectors based on funding agreements, plans and policy announcements
Distributed generation	Wind	Close to the lowest FES scenario	Higher than SP	• Slower than most FES scenarios consistent with slow growth observed following planning policy changes.
Distributed generation	Solar	In the middle of the FES scenarios	Close to TD	• Based on continued decrease in costs and moderate combined benefits of solar-storage hybrids
Distributed generation	Diesel & Gas	In the middle of the FES scenarios	Between CE TD	• Modest growth, but limited by reduction in embedded benefits, and environmental restrictions. Expected to see short-term benefit once Capacity Market re-established

More detail on how our assumptions compare with Future Energy Scenarios for England & Wales on pages 19, 20, 21 and Appendix 2 (pages 28 to 40)

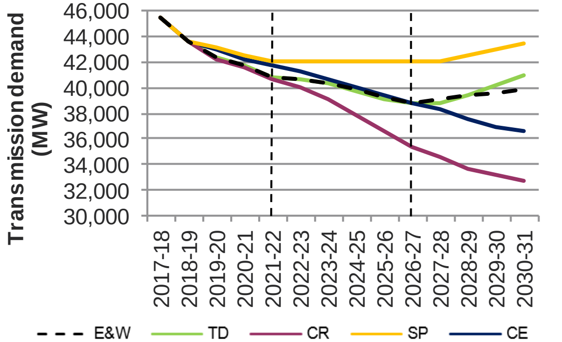
SP *Steady progression (lower decentralisation, lower decarbonisation)*
CE *Consumer evolution (higher decentralisation, lower decarbonisation)*
CR *Community renewables (higher decentralisation, higher decarbonisation)*
TD *Two degrees (lower decentralisation, higher decarbonisation)*

iv. Developing a single baseline scenario

Our initial view on the E&W scenario for transmission and underlying demand

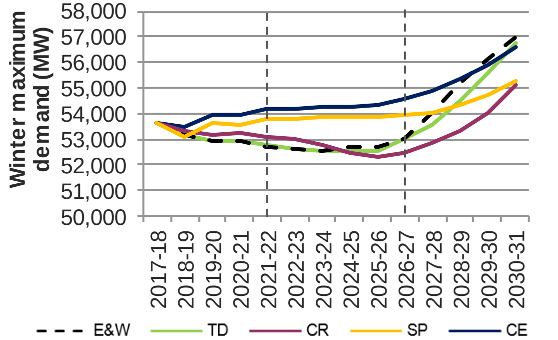
Underlying demand and transmission demand are two distinct concepts. In this case, underlying demand refers to the entire electricity consumption of end-users in E&W. Conversely, transmission demand is demand on the transmission system (i.e. underlying demand net of distribution generation and storage). Transmission demand is the primary demand driver for transmission investment.

Transmission demand – winter peak



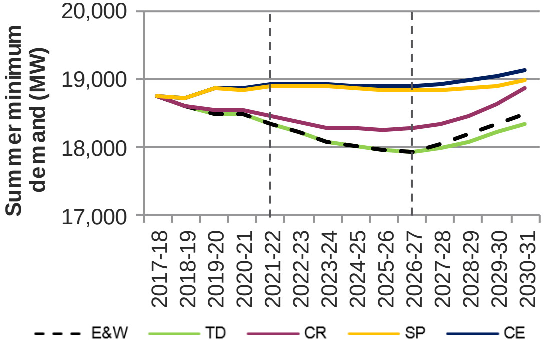
- Across the RIIO-T2 period, each FES scenario presents a gradually decreasing transmission demand (at different speeds). This is due to growth in distributed generation, appliance efficiency gains and low economic growth (despite a rising population).
- The E&W scenario broadly follows the Two Degrees FES scenario (high decarbonisation, lower decentralisation) up to 2030. This lies in the middle of the upper and lower bounds of the FES.
- Our view is based on the same underlying economic data where demand continues to fall due to lower economic growth and a drive for energy efficiency that is limited by available financing for consumers.
- Demand is more uncertain beyond the RIIO-T2 period and will largely depend on the speed and magnitude of the electrification of heat / transport (see the next page)

Underlying demand – winter peak



- Across the RIIO-T2 period, winter peak demand for each FES scenario is expected to be relatively flat or decreasing. Appliance efficiency gains and low economic growth, despite a rising population, moderate the rise in peak demand for the early to mid 2020s.
- In the late 2020s, winter peak demand is likely to increase in response to the electrification of transport and/or heat.
- The E&W scenario broadly follows the Two Degrees FES scenario (high decarbonisation, lower decentralisation) up to 2030. This lies near the lower bound of the FES until the mid to late 2020s.
- In the late 2020s, the E&W scenario increases at a faster pace due to our assumption that there will be lower levels of engagement in peak shifting demand.

Underlying demand – summer minimum



- Across the RIIO-T2 period, summer minimum demand for each FES scenario is expected to be relatively flat or decreasing. Appliance efficiency gains and low economic growth, despite a rising population, moderate the rise in peak demand for the early to mid 2020s.
- In the late 2020s, summer minimum demand remains either flat or increases slightly in response to the electrification of transport (more so than heat).
- As in winter peak demand, the E&W scenario broadly follows the Two Degrees FES scenario up to 2030. This lies near the lower bound of the FES.
- In the late 2020s, the E&W scenario increases at a slightly faster pace due to minor differences in a number of assumptions (e.g. energy efficiency).

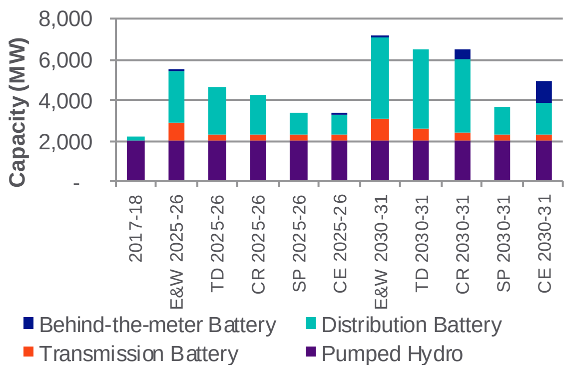
Seeking your views:

6. What are your views on the timing of the increase in winter peak and summer minimum demand at around 2026/27?

iv. Developing a single baseline scenario

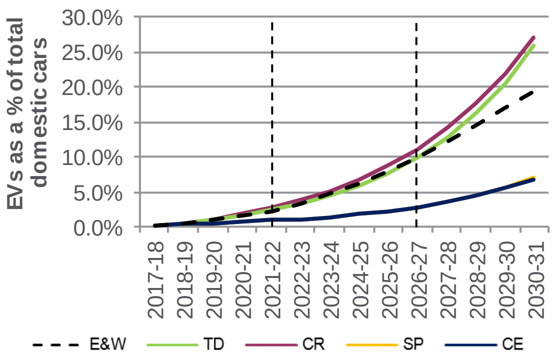
Our initial view on the E&W scenario for new demand

Overall storage capacity



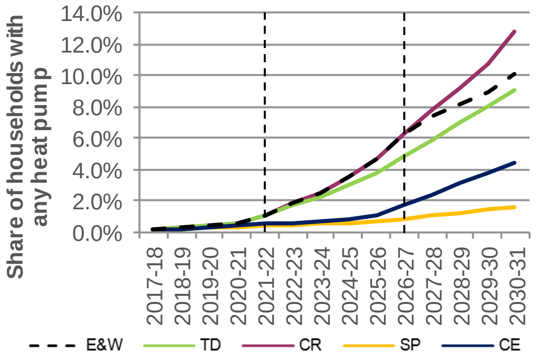
- Across each FES scenario, storage is expected to increase considerably over the next decade. The high decarbonisation scenarios (Community Renewables and Two Degrees) see the most significant increases in storage, particularly driven by distribution-connected storage.
- The E&W scenario presents a more optimistic view of storage than the FES scenarios in both 2025 and 2030. This is based on an additional confidence within the industry, now that a number of commercial large scale battery storage projects have connected and reflects an increase in transmission storage connection applications observed since the FES modelling.
- However, until the technology is fully established, some uncertainty around the ambitious deployment rate of these projects will exist. To reflect this we have taken a conservative view of the level and timing of connections.

Electric vehicle (EV) uptake



- Across each FES scenario, EV uptake is expected to increase, with different accelerating growth rates over the period.
- Scenarios with faster decarbonisation (Community Renewables and Two Degrees) have higher adoption rates for EVs. Slower decarbonisation scenarios (Steady Progression and Consumer Evolution) have slower uptake of EVs.
- The E&W scenario follows the faster decarbonisation scenarios, taking into account recent government policy announcements as well as car manufacturers' plans.
- To reflect a more cautious view, we have assumed a slower growth in the late 2020s due to the additional policies that are required to meet the higher EV uptake profiles assumed in the higher decarbonisation scenarios.

Heat pump uptake



- Across each FES scenario, heat pump uptake is expected to increase, with different accelerating growth rates over the period.
- Scenarios with faster decarbonisation (Community Renewables and Two Degrees) have higher adoption rates for heat pumps. Slower decarbonisation scenarios (Community Renewables and Two Degrees) have a slower uptake of heat pumps.
- The E&W scenario assumes a heat pump uptake in line with the fastest FES scenario (at least until the mid 2020s). This assumes the introduction of policy to decarbonise heating in off-gas grid properties (as recommended by the Committee on Climate Change), and incentives to assist with initial costs. This growth slows in the late 2020s as competing technologies, such as hydrogen, begin to emerge.

[1] *CCC, 21 Feb 2019, UK housing: Fit for the Future?*

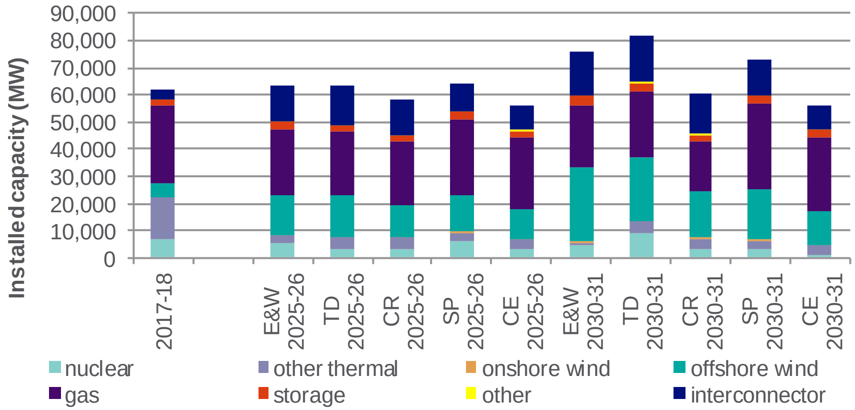
Seeking your views:

7. What are your views on our general confidence in (i) storage, (ii) EV and (iii) heat pump uptake in the 2020s?
8. Are there other technologies we should consider (e.g. large-scale hydrogen production / other forms of storage)?
9. We have assumed that the rate of EV and heat pump uptakes are equal across all regions. Do you have any additional, local insight indicating that this might not be the case?

iv. Developing a single baseline scenario

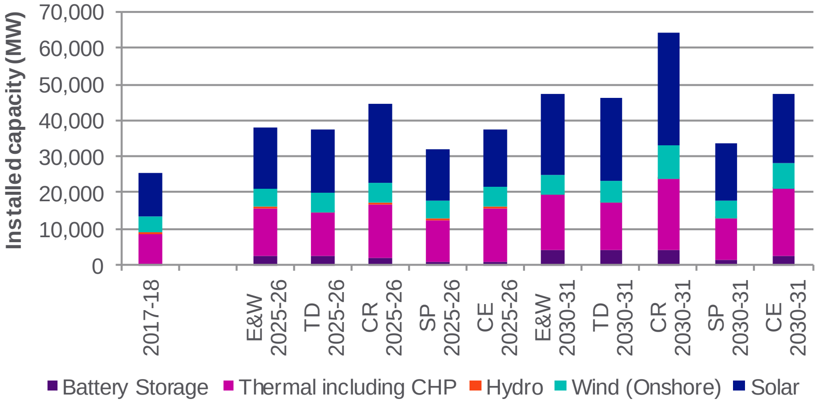
Our initial view on the E&W scenario for generation, interconnectors & storage

Transmission-connected technologies



- Transmission capacity is expected to remain relatively flat in the more decentralised FES scenarios (Community Renewables and Consumer Evolution) but increases slightly in the lower decentralisation scenarios.
- Based on various evidence, the E&W scenario makes several key assumptions underpinning the forecast:
  - More offshore wind capacity based on cost reductions evidenced in the most recent CfD auctions; the recent suspension of nuclear projects limiting large-scale low carbon alternatives, and the expected offshore wind sector deal.
  - Strong growth of interconnector capacity based on projects with cap and floor funding agreements and government ambition.
  - A more pessimistic view on transmission gas plants (towards the lower end of the range of the FES), due to the impact of the Capacity Market suspension.
  - No new nuclear up to 2030 apart from Hinkley Point C which becomes operational from 2025. No further life extensions on existing nuclear.

Distributed generation and storage technologies



- All FES scenarios forecast a significant, but largely varied increase in installed distribution and behind-the-meter generation. These are driven by varying levels of solar and gas reciprocating engines. Growth in onshore wind is expected to remain relatively low.
- Based on various evidence, the E&W scenario makes several key assumptions underpinning the forecast:
  - A central view of the level of solar and onshore wind capacity.
  - A modest increase in gas reciprocating engines (with environmental restrictions on diesel engines expected to remain). The suspension (and expected reintroduction) of the capacity market and reduction in embedded benefits will impact growth in this area.
  - A confident view of battery storage (marginally exceeding the FES in 2025 and towards the upper end in 2030). This is based on increasing confidence within the industry, now that a number of commercial large scale projects have connected.

[1] interconnectors

Seeking your views:
10. What are your views on our expected changes to transmission-connected generation up to 2030?
11. What are your views on our expected changes to distributed generation up to 2030?

v. Proposed approach to uncertainty mechanisms in the T2 period

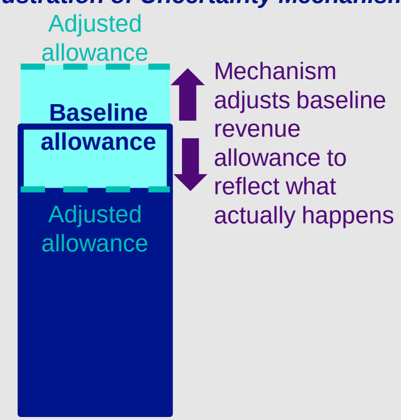
Uncertainty mechanisms ensure only outputs delivered are remunerated

Overview

Uncertainty mechanisms are a key component of incentive based price controls that ensures consumers only pay for the outputs that are actually delivered.

Given the lack of predictability in future market conditions, these mechanisms are particularly important for investments that might be needed to accommodate changes to demand and generation.

Illustration of Uncertainty Mechanism



Whilst the RIIO-T1 framework contains a number of uncertainty mechanisms, those that adjust baseline revenue up or down by a unit cost allowance to reflect the actual amount of capacity or connections provided on the network are the focus of this consultation.

For RIIO-T1, we developed a suite of uncertainty mechanisms as part of our approach to dealing with risk and uncertainty that was rated highly in Ofgem's assessment at the time. There were three primary categories of outputs that these uncertainty mechanisms apply to:

Network connections: The volume of new generation and demand connections to the electricity transmission network

Network reinforcement: The volume of additional capacity required to manage changes in power flows across the network

Planning requirements: The level of visual amenity and undergrounding required to achieve planning consents

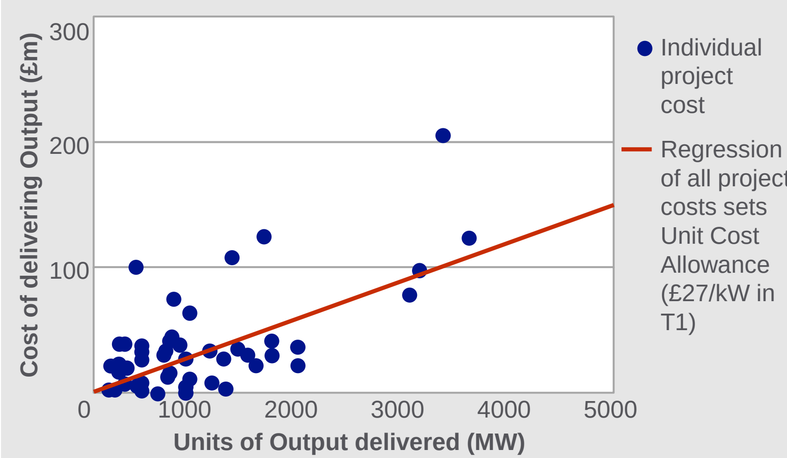
Common design features of uncertainty mechanisms

Mechanisms that adjust baseline revenue for the three categories highlighted have common design features:

- **Unit Cost Allowance (UCA):** determines the amount that the allowance is adjusted when the actual volume of output delivered is different from the baseline forecast.
- **Time lags & smoothing**: determines when the allowance is adjusted to make the changes more predictable as well as to reduce the variation in consumer bills.
- **Indexation and edge effects**: adjusts the UCA for inflation and real price effects (indexation) and for outputs that would be completed in the next period (edge effects).

The unit cost allowance is the main component of the mechanism that is calculated for each relevant output category as part of the price control. An illustration of the calculation for network connections is shown, below.

Illustration of Unit Cost Allowance for network connections



v. Proposed approach to uncertainty mechanisms in the T2 period

Seeking your views on improving uncertainty mechanisms in RIIO-T2

Review of uncertainty mechanisms in RIIO-T1

The uncertainty mechanisms introduced on the previous page have broadly worked well in RIIO-T1. The energy scenario used for the E&W baseline allowances at the time, Gone Green, was on the edges of the FES envelope of credible futures. Since the start of the T1 period in April 2013 there have been significant changes in the amount of transmission-connected generation envisaged in the Gone Green scenario (down from 26GW to 13GW). Likewise, there has been a significant change in the forecast of demand connections, reflected in the reduction of the number of Demand Outputs (or Super Grid Transformers) from 72 to 40.

This significant change in expectations of market conditions was reflected well by the uncertainty mechanisms – automatically reducing our baseline revenue allowance by over £2bn, which has been very valuable for consumers.

Operation of uncertainty mechanism on revenue allowance in RIIO-T1

Improving uncertainty mechanisms in RIIO-T2

While uncertainty mechanisms have been successful in RIIO-T1, there are aspects that could be improved for T2. We are working on improving these mechanisms and are keen to hear your views.

We propose to build on the existing RIIO-T1 mechanisms by:

- **Re-designing existing UCAs**: we are looking to find the right balance between complexity and cost-reflectivity when considering how to reduce the volatility of allowances compared to costs, which would in turn make charges more stable.
- **Developing UCAs for new categories**: new UCAs could be developed to further improve the flexibility of the price control in areas where the existing set of mechanisms might fall short. For example, the following areas are not currently covered:
  - i. Changes to the transmission network needed as a result of generation connecting to distribution networks;
  - ii. Pre-construction work that does not lead to delivery of an output (e.g. to keep options open as recommended through the Network Options Assessment process).
- **When a UCA may not be appropriate**: some outputs are not suited to a UCA approach because they are difficult to define now, such as rapid charging for electric vehicles. We are considering how an anticipatory investment mechanism could work for this type of requirement. Initial stakeholder reaction has been relatively positive.

Seeking your views:

12. What are your views on our proposals for improving uncertainty mechanisms for RIIO-T2? Have we missed anything?
13. Are you supportive of our proposal to develop an anticipatory investment mechanism in more detail?

5 Summary and next steps

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Summary and next steps

Summary

The changing energy landscape is increasing the uncertainty of future market conditions which has implications on the role of the transmission network, how we plan our business, and how we manage uncertainty.

Our objective is to manage uncertainty in a way that is likely to deliver the most long-term value to consumers. As part of a series of stakeholder engagements, this consultation document seeks your views on how we should go about achieving this. We focus on two areas:

Business planning	• The need for and role of electricity transmission networks beyond the T2 period. • The approach to business planning for the future. • The range of possible future scenarios to plan against.
Setting the RIIO-T2 price control	• A baseline scenario sets the view of the future which RIIO-T2 is built on. A refined E&W-specific scenario would determine the initial NGET revenues and investment plans. • Uncertainty mechanisms adjust the baseline to ensure consumers only pay for outputs that are needed and delivered.

Next steps

The upcoming RIIO-T2 price control offers a unique opportunity to evolve and improve the way we deal with uncertainty. With your views in response to this consultation, we will:

- improve our outlook of the future and business planning process to ensure we're ready to enable the ongoing energy transition; and
- refine our England & Wales baseline scenario and uncertainty mechanisms to ensure consumers only pay for the outputs we deliver and we minimise the volatility our customers experience when things change.

We aim to continue consulting with stakeholders over the next few months to build our RIIO-T2 business plan through a transparent and iterative process.

Seeking your views:

Business planning for the future

1. Have we captured your views correctly on the future of electricity transmission?
2. Is there anything else you would like to add to these views?
3. Are the Future Energy Scenarios, further informed by regional insights, a suitable range for planning our business? If not, what else should we consider?

Managing uncertainty in setting the RIIO-T2 price control

4. What are your views on our approach to developing an England & Wales baseline scenario for electricity transmission?
5. Should we aim to set a baseline for electricity transmission in England & Wales that is more likely to (i) increase, (ii) maintain or (iii) decrease revenue allowances via uncertainty mechanisms across the price control period?
6. What are your views on the timing of the increase in winter peak and summer minimum demand at around 2026/27?
7. What are your views on our general confidence in (i) storage, (ii) EV and (iii) heat pump uptake in the 2020s?
8. Are there other technologies we should consider (e.g. large-scale hydrogen production / other forms of storage)?
9. We have assumed that the rate of EV and heat pump uptakes are equal across all regions. Do you have any additional, local insight indicating that this might not be the case?
10. What are your views on our expected changes to transmission-connected generation up to 2030?
11. What are your views on our expected changes to distributed generation up to 2030?
12. What are your views on our proposals for improving uncertainty mechanisms for RIIO-T2? Have we missed anything?
13. Are you supportive of our proposal to develop an anticipatory investment mechanism in more detail?

How you can respond to this consultation: This consultation is aimed at all users of our network, government, regulatory bodies and energy industry professionals. We also welcome responses from anybody who is interested in the future of electricity transmission. Simply send your views to gary.stokes@nationalgrid.com by 1 April 2019.

Appendix 1

Collaborating to develop a common scenario for Great Britain

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Collaborating to develop a common scenario for Great Britain

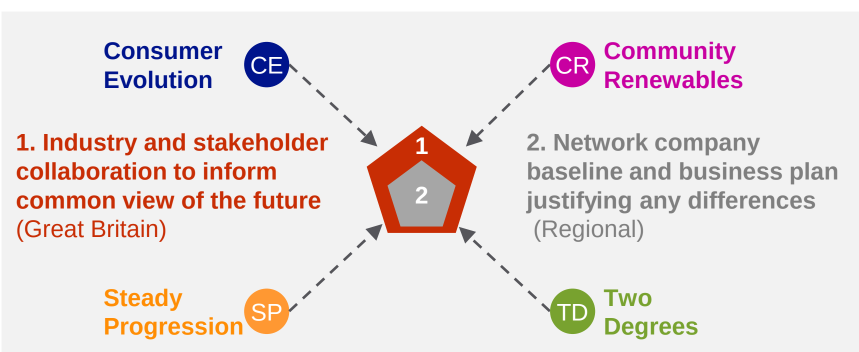
"Common view of the future" overview

NGET is working with all the other regulated energy networks and Ofgem's independent RIIO-2 Challenge Group to develop a single "common view of the future". This view is intended to be shared by the different network companies to support development of RIIO-2 business plans that can be flexed to meet a range of scenarios.

The process of developing a common view of the future is threefold:

- providing a range of drivers to set a consistent view of the future; *completed at 20 December 2018*
- showing how these drivers feed into a proposed common view; *completed at 31 January 2019*
- providing a finalised common view of the future. *ongoing – expected completion in March 2019*

As introduced in page 16, the work to determine a common view of the future uses the 2018 FES scenarios as a starting point. These scenarios are then refined through an evaluation of key drivers taking into account a variety of cross-sector analysis, market and commercial intelligence, and stakeholder feedback.[1]

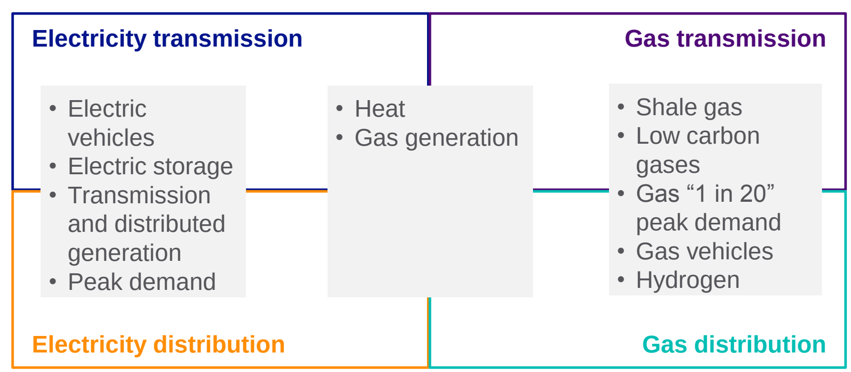


Whole system, cross-sector collaboration

One of the key opportunities of developing a common view is the ability to consider the cross-sector interactions across the energy system to form a whole-systems view. This is especially crucial in drivers that have greatest uncertainty:

- **Decarbonisation of heat** – as heat policy is still being developed, it is unclear on the scale of adoption of new heating technologies (hybrid heat pumps, district heating, hydrogen-based).
- **Decarbonisation of transport** – mostly on Electric Vehicles but also in rail and the long-term role of hydrogen. Uptake rates, charging infrastructure and consumer behaviours are all uncertain.
- **Generation** – while the next few years are relatively predictable, there is considerable uncertainty over the medium to long term due to ongoing changes to policy and wider market arrangements.

The drivers and areas of uncertainty have different impacts on each part of the energy sector. This highlights the need for 'whole system' plans and funding mechanisms that allow flexibility (rather than relying on forecasting accuracy).



[1] Factors and scenarios that feed into the common view of the future include the FES, other regulatory initiatives, Government policy, customer contracts, whole system demand & supply forecasting, existing plans and stakeholder feedback

Appendix 2

Additional scenario analysis and commentary

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Selected key drivers of the E&W scenario in Appendix 2

Selected key drivers assessed across scenarios

We present the following key drivers and commentary in Appendix 2:

(1) (2) Demand (3)

- **"Base" demand**
  - Economic activity
  - Energy efficiency
  - Consumer behaviour
  - Industrial processes
- **"New" Demand**
  - (6) Energy storage
  - (4) Electric vehicles
  - (5) Heat pumps
  - Demand-side response

(7) Generation, interconnection & storage

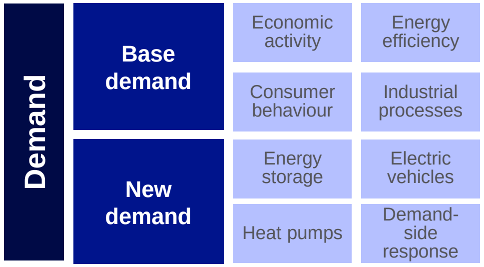
- **(8) Transmission-connected**
  - Supply decline (e.g. coal, nuclear)
  - Interconnectors
  - Other connections
  - Asynchronous generation (10) (11)
- **(9) Distribution-connected**
  - (10) Wind
  - (11) Solar
  - Diesel & Gas
  - (6) Energy storage

Legend for charts in appendix

- E&W – *NGET's initial E&W scenario (to be refined through the "common view of the future" work and your views)*
- TD – *Two degrees (lower decentralisation, higher decarbonisation)*
- CR – *Community renewables (higher decentralisation, higher decarbonisation)*
- SP – *Steady progression (lower decentralisation, lower decarbonisation)*
- CE – *Consumer evolution (higher decentralisation, lower decarbonisation)*

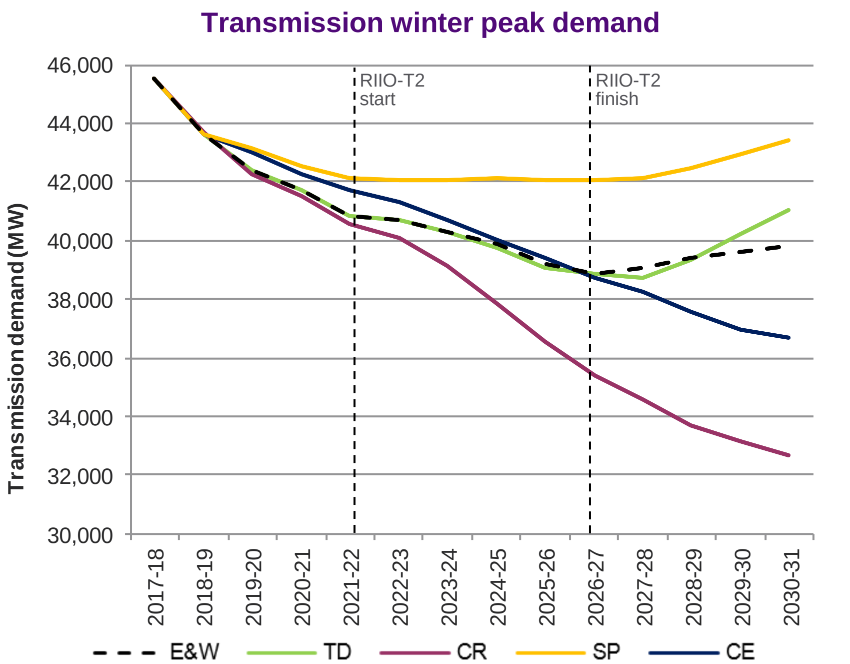
1. Winter peak demand on the transmission network

Drivers of demand



- Winter peak demand on the transmission network is key to informing transmission investment planning decisions

E&W scenario



Commentary

FES scenarios

Transmission demand falls at varying speeds across each FES scenario. This reflects a number of factors, with expected increases in distributed generation being the most significant. Other factors include general economic activity, improvements in energy efficiency, appliance efficiency gains and consumer behaviour.

The Steady Progression scenario is the most optimistic FES scenario from a transmission demand perspective; demand broadly plateaus across the 2020s whereas the other three scenarios continue to drop. This is driven by assumptions of both a low level of decentralisation and low levels of decarbonisation leading to a greater utilisation of the transmission network than the other scenarios.

There is a greater diversion in the FES scenarios from 2027. This reflects the different assumptions on when and how much EV and heat pumps technologies will be adopted. However, in the two decentralised scenarios (Community Renewables and Consumer Evolution), the increase in distributed generation outweighs the increase due to EVs and heat pumps.

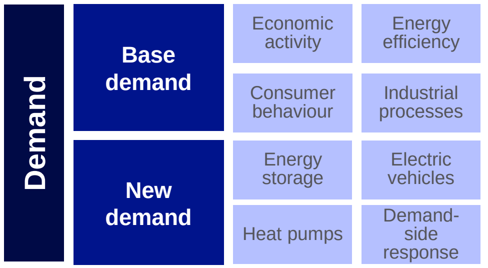
E&W scenario

The E&W scenario is positioned in the middle within the FES scenarios. Between 2020/21 and 2025/26 (i.e. over the RIIO-T2 price control period), the E&W scenario follows the Two Degrees scenario.

This reflects our beliefs that transmission demand will fall gradually with increased energy efficiency linked to decarbonisation, and increased distributed generation and energy storage. From 2027 onwards, the fall in demand is negated by the increase from the decarbonisation of transport and heat.

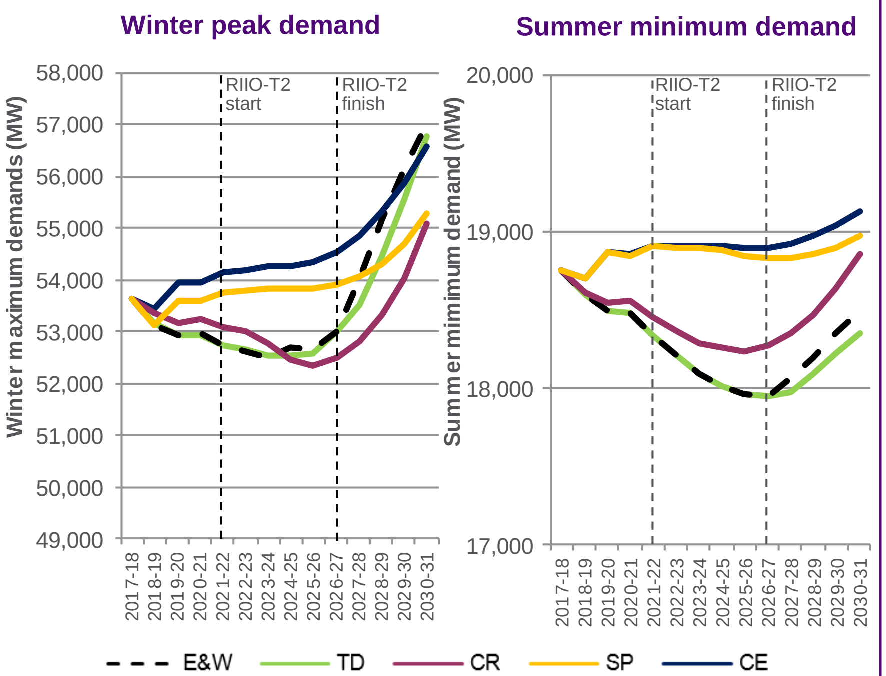
2. Underlying winter peak and summer minimum demand

Drivers of demand



- Underlying winter peak and summer minimum demand sets out the two ‘extreme’ ends of total demand requirements
- This would inform transmission investment requirements (subject to the degree of distributed generation)

E&W scenario



Commentary

FES scenarios

Across each FES scenario, winter peak and summer minimum demand are expected to increase significantly in the late 2020s in response to the electrification of transport and/or heat. Appliance efficiency gains and low economic growth, despite a rising population, moderate the change in winter peak and summer minimum demand for the early to mid 2020s.

Each FES scenario follows a similar trend in winter peak and summer minimum. In the scenarios with slower decarbonisation (Consumer Evolution and Steady Progression), demand is expected to increase in the early 2020s. In scenarios with faster decarbonisation (Community Renewables and Two Degrees), industrial, commercial and domestic demand is expected to continue falling, with increases due to electrification of heat and transport increasing demand in the late 2020s.

E&W scenario

The E&W scenario follows the Two Degrees scenario adopting realistic assumptions on economic activity, energy efficiency and consumer behaviour, continuing the trends over the last 10 years.

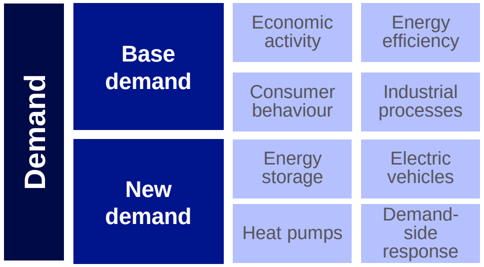
This also reflects a more cautious approach to demand (given the general difficulties in forecasting demand) with the view to setting an E&W scenario that would translate to a conservative allowance.

From the late 2020s, we expect both winter peak and summer minimum demand to increase faster than the TD scenario due to lower overall engagement in demand shifting and slightly lower energy efficiency.

We do not anticipate an uptake in air-conditioning to have a material impact on the summer minimum demand.

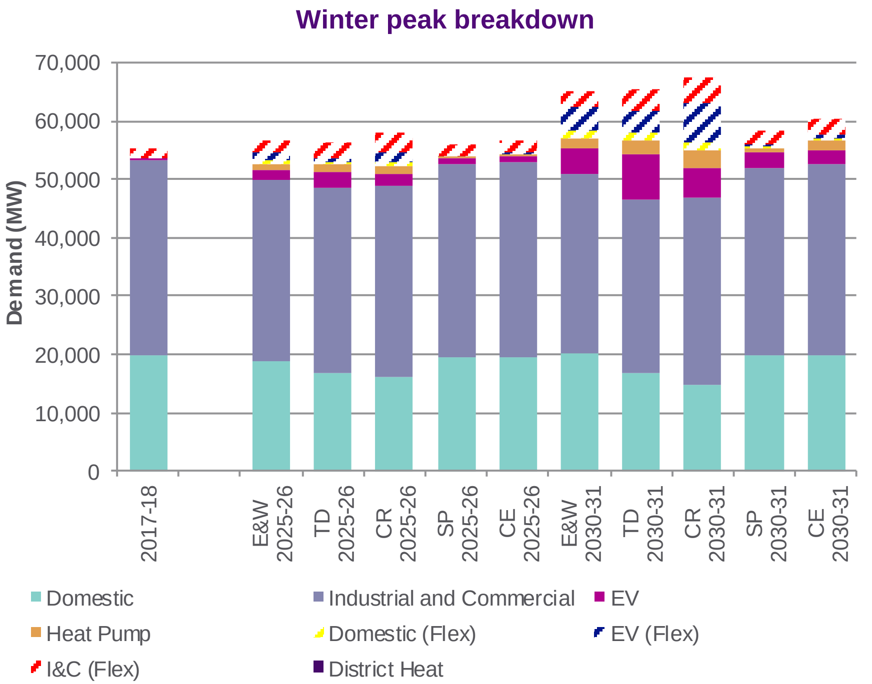
3. Flexible winter peak demand

Drivers of demand



- The key components of winter peak demand provide a helpful indication on the potential drivers of network requirements.
- In particular, we highlight "flexible demand" i.e. demand that could potentially be shifted away from peak periods.

E&W scenario



Commentary

Winter peak demand is made up of different types of demand – domestic, the industrial & commercial sector, EVs, heat pumps and district heat. Domestic, industrial & commercial, and EV demand, could be further divided into flexible and inflexible demand. Flexible demand represents the demand that could potentially be shifted away from peak periods if there are sufficient economic price signals and/or incentives to do so. In effect, this flexible demand sets out the potential for demand-side response (DSR).

FES scenarios

Across each FES scenario, the amount of flexible demand is expected to increase across all components. Flexible demand from the domestic, industrial & commercial and EV sectors have relatively large variations (around 12 GW in the Two Degrees scenario and 3 GW in the Steady Progression scenario).

E&W scenario

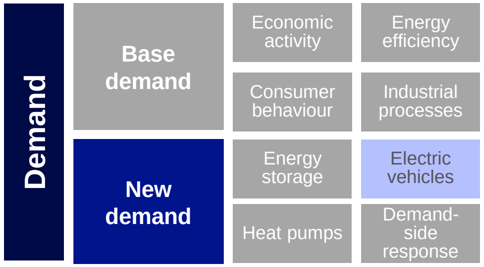
Flexible demand in each component / demand type is driven by:

- the number of technologies adopted (i.e. EVs and charging infrastructure, energy management tools, smart technology etc);
- the ability to shift demand away from the peak (i.e. automated controls); and
- the level of consumer engagement / response to do so (i.e. behavioural trends, economic price signals).

The E&W scenario is fairly optimistic on the number of technologies and ability to be flexible (in line with the Two Degrees scenario). However, the E&W scenario assumes a lower overall level of consumer engagement by the late 2020s. Overall, this places the E&W scenario between the Two Degrees and Consumer Renewables scenarios.

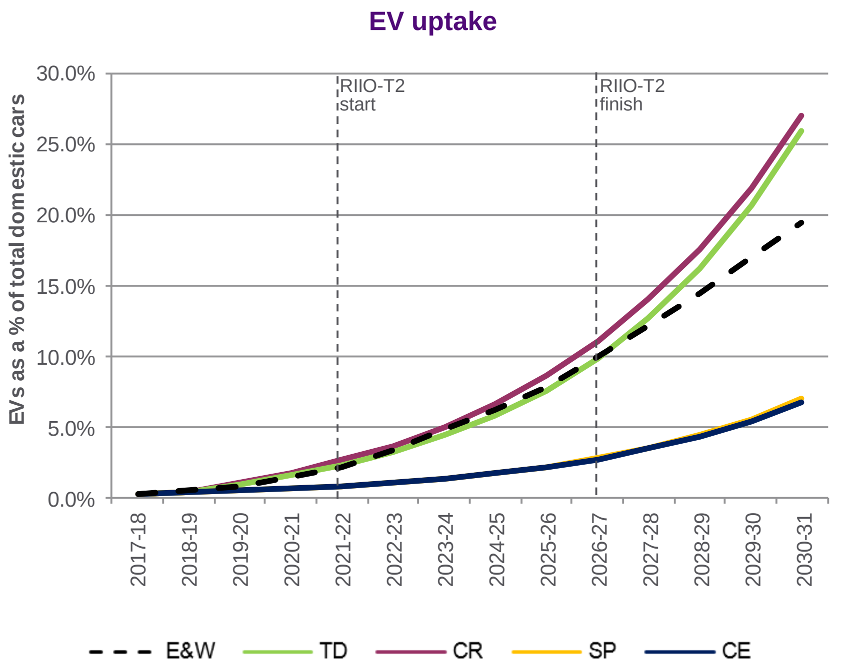
4. EV uptake (percent of total domestic cars)

Drivers of demand



- The ongoing decarbonisation of transport, in particular EVs, has the potential to significantly impact demand.
- Because of difficulties forecasting EV uptake, this could materially affect the sector in the medium term.

E&W scenario



Commentary

FES scenarios

In all scenarios, EV uptake is expected to increase, with accelerating growth over the period.

Scenarios with faster decarbonisation (Community Renewables and Two Degrees) have higher growth rates for EVs as adoption of low emission technologies is assumed to grow at the fastest rates in these scenarios.

The slower decarbonisation scenarios have slower uptake of EVs. However, growth rates start to accelerate in the late 2020s as EVs become the lowest upfront cost option compared to internal combustion engine cars.

E&W scenario

The E&W scenario initially follows the fast decarbonisation scenarios which represent the fastest uptake of EVs. This is based on government policy announcements promoting the shift to electric vehicles (especially in cities targeting lower emission zones).

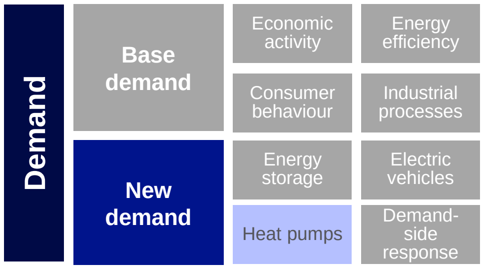
Additionally, car manufacturers are preparing to release their second generation EVs, with significant performance and range upgrades. Therefore, the E&W scenario follows the higher FES adoption rates.

However, after 2025, the E&W scenario assumes lower growth rates than the fast decarbonisation scenarios. This is due to a need for additional government policy being required to meet long term decarbonisation targets.

Going forward, additional analysis on the locational "clustering" of EVs might be important to understand the impact on the network (please refer to Question 9 on page 25 .

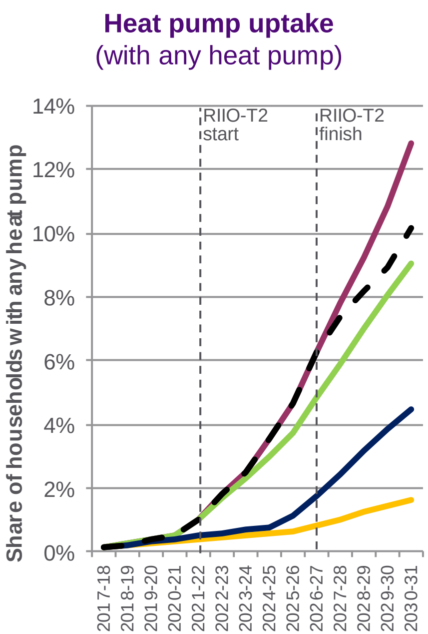
5. Heat pump uptake (percent of households with heat pumps)

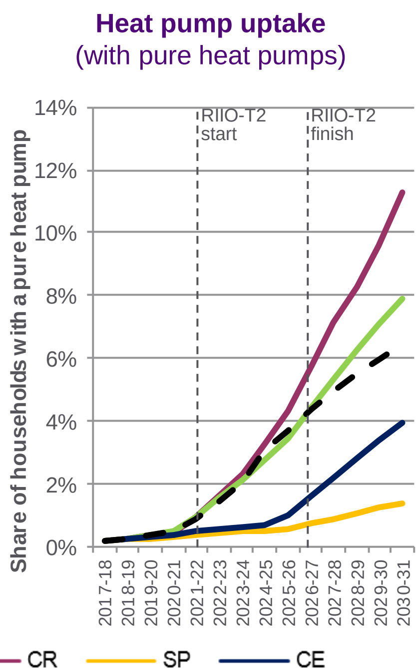
Drivers of demand



- Policies that seek to decarbonise heat are currently being developed
- These policies (assuming sufficient consumer engagement) have the potential to affect demand significantly

E&W scenario





Commentary

Pure heat pumps refer to fully-electric heating technologies. Conversely, the wider definition of heat pumps may also include hybrids, which use alternative fuels at lower temperatures (coinciding with peak demand).

FES Scenarios

In all scenarios, heat pump uptake is expected to increase, with accelerating growth over the period.

Scenarios with faster decarbonisation (Community Renewables and Two Degrees) have higher growth rates for heat pumps as adoption of low emission technologies is assumed to grow at the fastest rates in these scenarios. The Community Renewables scenario decarbonises heat almost completely through heat pumps, whereas the Two Degrees scenario uses a combination of heat pumps and hydrogen.

Slower decarbonisation scenarios have a slower uptake for heat pumps. However, growth rates start to accelerate from 2025 as heat pumps become the lowest up front cost option compared to conventional gas boilers.

E&W scenario

The E&W scenario initially follows the faster decarbonisation scenarios. This is based on our expectations that the electrification of heat has had increasing support and confidence (for example, the Committee on Climate Change has set out a confident outlook on domestic heat pumps)[1]. The E&W scenario does not assume any significant hydrogen usage until after the RIIO-T2 price control period.

This growth slows in the late 2020s as competing technologies begin to emerge and challenges arise in incentivising a larger portion of domestic consumers to shift to a different form of heating (e.g. cost considerations and confidence in new heat pumps).

[1] CCC, 21 Feb 2019, UK housing: Fit for the Future?

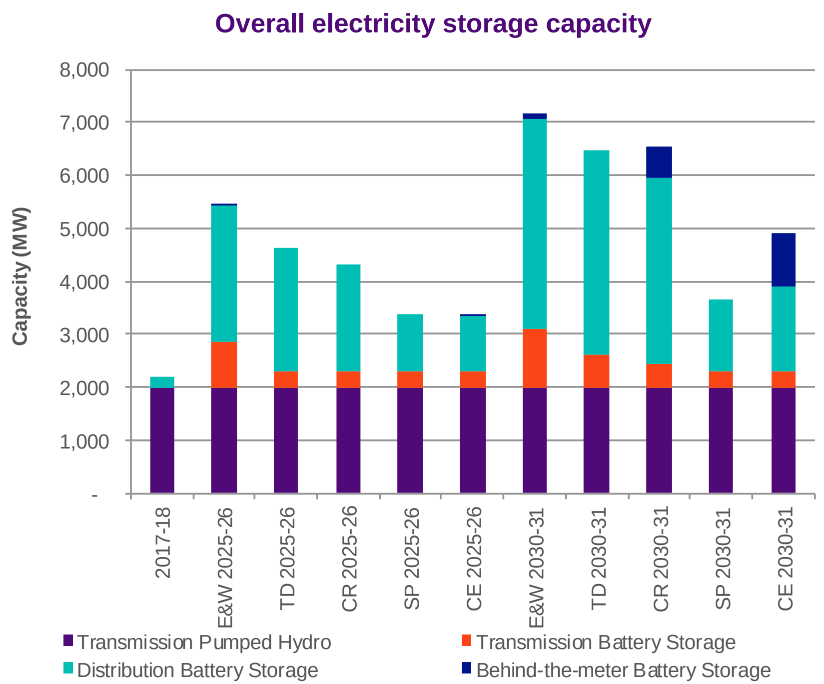
6. Overall electricity storage capacity

Drivers of demand and generation

D	**New demand**	Energy storage	Electric vehicles
		Heat pumps	Demand-side response
G	**Distribution-connected**	Wind	Solar
		Diesel & Gas	Energy storage

- Electricity storage is an emerging technology that has the potential to disrupt the energy sector
- We focus primarily on battery storage (in addition to existing pumped hydro storage units)

E&W scenario



Commentary

FES Scenarios

All FES scenarios anticipate significant increases in storage capacity over the period (mostly driven by distribution-connected battery storage), with some variations across the scenarios.

On distribution-connected battery storage, the higher decarbonisation scenarios (Community Renewables and Two Degrees) forecast a much higher amount of capacity than the lower decarbonisation scenarios (Steady Progression and Consumer Evolution).

On transmission-connected battery storage, a similar increase in capacity is assumed across the scenarios.

On behind-the-meter battery storage, the higher decentralisation scenario (Community Renewables and Consumer Evolution) forecasts a modest increase in capacity.

No new pumped hydro storage is assumed by 2030.

E&W scenario

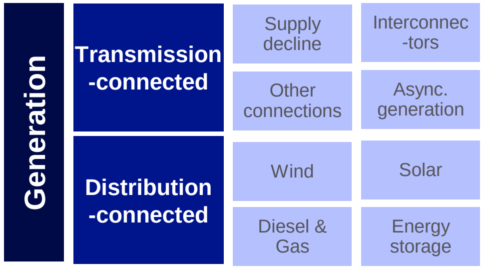
The E&W scenario assumes a higher storage capacity than any of the FES scenarios. This is driven by the recent significant increase in the appetite for new transmission connections for battery storage projects. This is based on internal commercial intelligence as we have received several GW of applications for battery connections.

Whilst the emergence of a number of large scale projects, provides added confidence in this sector, the technology is not yet fully established. With this in mind, we have taken a conservative view of the number of projects connecting and their timing.

The levels of other storage capacity are broadly in line with the higher decarbonisation scenarios.

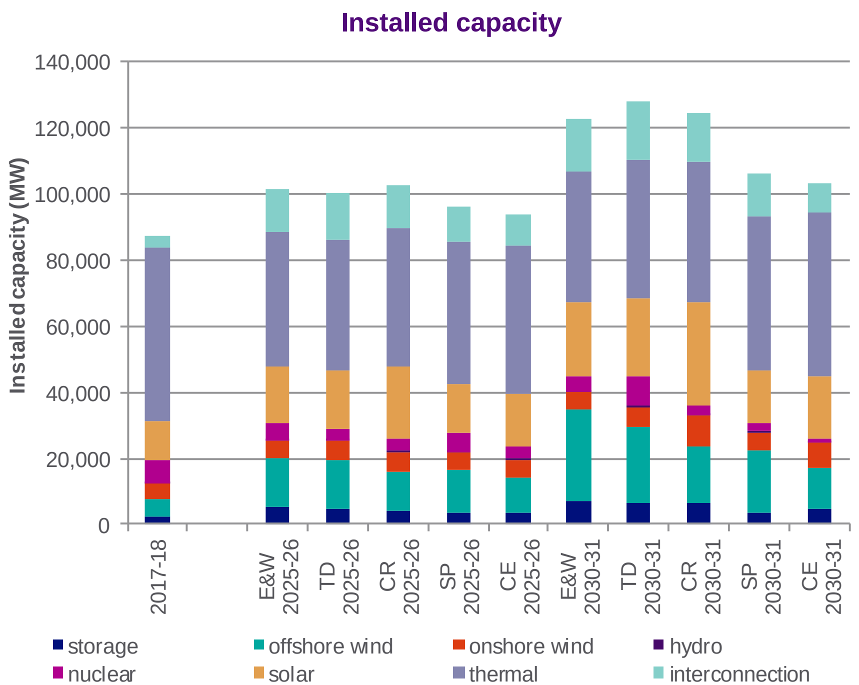
7. Installed transmission and distribution generation, interconnection and storage capacity

Drivers of generation



- Forecast generation capacity informs business planning on how the transmission network would need to operate, and the potential investment requirements
- Each technology and where it connects would have different impacts on the system

E&W scenario



Commentary

We set out an overview of the different scenarios of generation capacity below. We assess them in further detail over the next few pages.

Note that these charts display the installed capacity (based on the 'nameplate' capacity of each generator) and are not de-rated (to reflect the expectation of actual availability at peak demand periods).

FES Scenarios

In all scenarios, total installed capacity across transmission and distribution is expected to increase – more so towards the late 2020s. This is largely driven by increased renewables, with lower load factor (TWh output per MW of installed capacity)

The installed capacity at 2025 is relatively steady across all scenarios. The scenarios which have higher levels of decarbonisation (Community Renewables and Two Degrees) see greater increases in installed capacity, led by offshore wind and solar and interconnectors.

By 2030, installed capacity varies more considerably across the scenarios – driven again by more offshore wind, solar and interconnector capacity. Additionally, there is greater variation in nuclear assumptions and onshore wind generation.

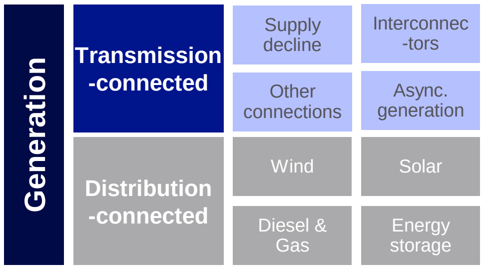
E&W scenario

The E&W scenario is set towards the top end of the FES range. This is because the E&W scenario considers a credible profile that could meet decarbonisation targets. In addition, we have considered the impact of policies (e.g. suspension of the Capacity Market and the expected Sector Deal for offshore wind); and market and commercial intelligence (e.g. potential ongoing planning difficulties for onshore wind).

We set out our views and assumptions on specific technologies below.

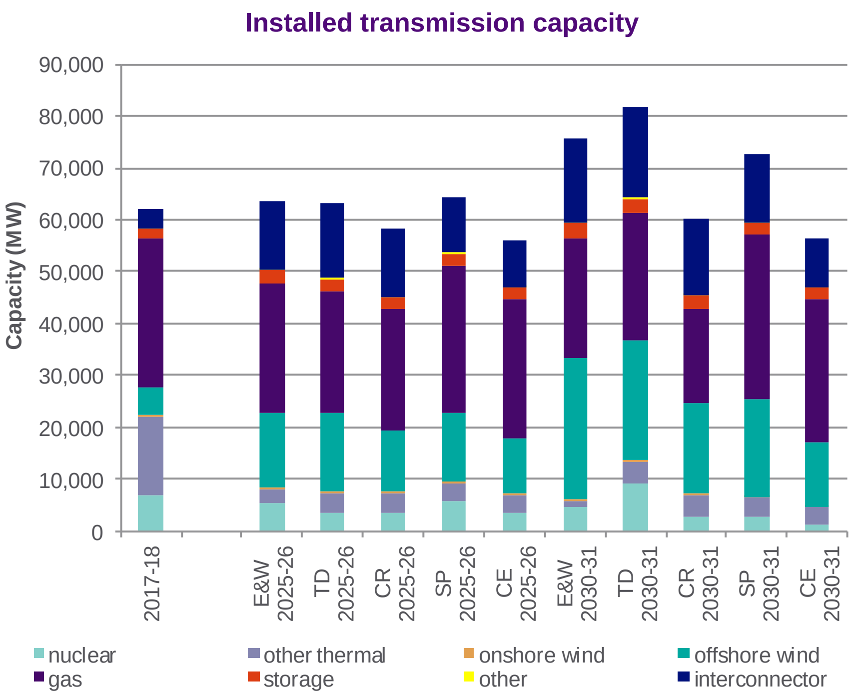
8. Installed transmission generation, interconnection and storage capacity

Drivers of generation



- The forecast change in transmission generation capacity indicates how the transmission network might evolve
- The timings, location and size of plant closures, new plant connections would have a material impact

E&W scenario



Commentary

FES Scenarios

The capacity of transmission connected generation differs across the FES scenarios, becoming more pronounced towards the late 2020s.

Total transmission capacity increases in the lower decentralisation scenarios (Two Degrees and Steady Progression) but falls slightly in the higher decentralisation scenarios. In summary, the key trends are:

- all scenarios expect a rapid closure of coal generation by 2025;
- all scenarios expect significant growth in offshore wind and interconnectors at varying degrees; and
- the nuclear assumptions, particularly at 2030, vary notably.

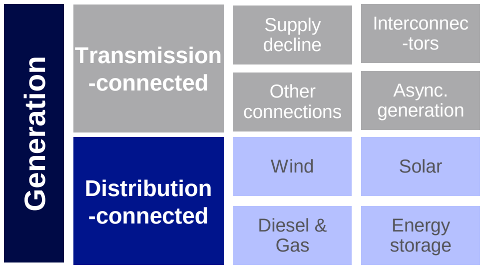
E&W scenario

The E&W scenario fits closer to the Two Degrees scenario (assuming decarbonisation targets are met). The key assumptions are:

- connection of Hinkley Point C in 2025/26 with no other new nuclear before 2032, with no further life extensions on the existing fleet.
- higher offshore wind assumptions than the FES scenarios (due to recent cost reductions, and the expected sector deal);
- more interconnection based on those with funding agreements (e.g. cap and floor) and government ambition;
- significantly lower thermal than assumed in the FES – due to a combination of closures of existing CCGTs as well as delays to future CCGT connections. This is based on the (current) suspension of the Capacity Market which may have greater “spill-over effects” on CCGTs relative to other technologies, and commercial intelligence on individual projects.

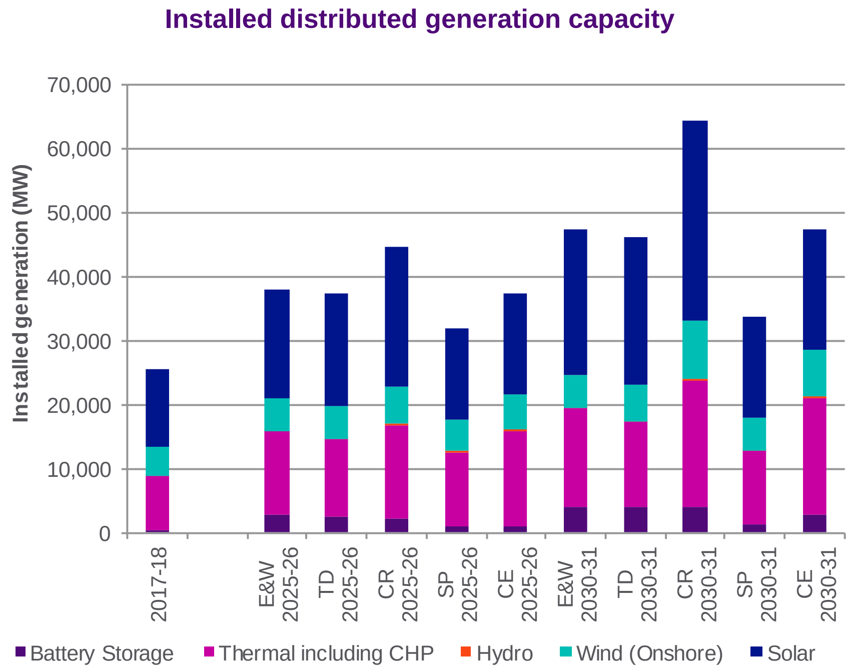
9. Installed distributed generation and storage capacity

Drivers of generation



- Distributed generation affects the transmission network by substituting for transmission generation capacity, effectively functioning as a “negative demand” from a transmission perspective.

E&W scenario



Commentary

FES Scenarios

All FES scenarios forecast a significant increase in distributed generation at varying rates across different technologies. With a range of 30GW in 2030, this is the largest area of uncertainty affecting our plan.

The Community Renewables scenario (higher decentralisation and higher decarbonisation) forecasts the largest increase in distributed generation. This is followed by the Two Degrees and Consumer Evolution scenarios (with the former more optimistic on solar where it reaches cost parity at a faster rate). In summary, the key trends are:

- all scenarios expect a significant increase in battery storage (see page 35, thermal generators and solar capacity); and
- all scenarios expect a more moderate increase in onshore wind capacity).

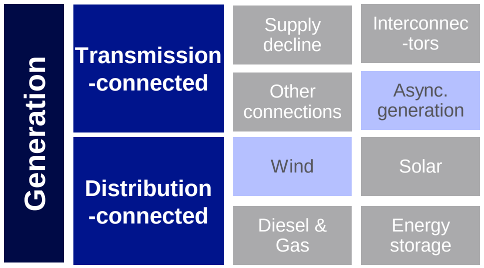
E&W scenario

The E&W scenario is set lower than the Community Renewables scenario and is more closely aligned with the Two Degrees and Consumer Evolution scenarios. The E&W scenario assumes:

- modest growth in thermal generation, limited by the reduction in embedded benefits, and environmental restrictions, but expected to benefit from a number of shorter timeframe auctions following the reintroduction of the Capacity Market due to a shorter lead time compared with large scale plant;
- higher end of the range for storage (see page 35);
- lower end of the range for onshore wind (see page 39);
- middle of the range for solar (see page 40).

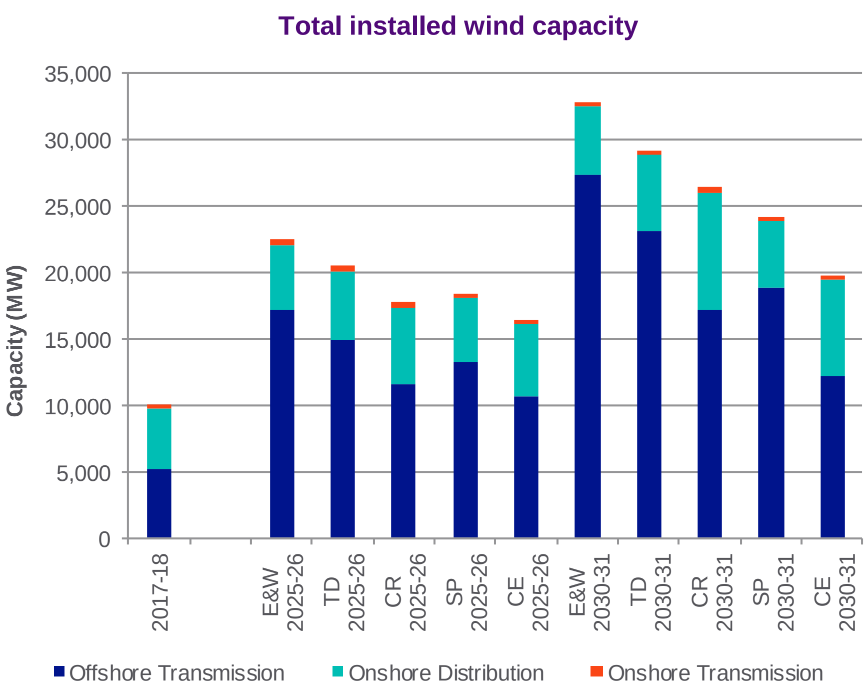
10. Installed wind capacity

Drivers of generation



- Intermittent wind generation is expected to continue increasing thereby changing the way the energy system and networks operate (depending on the type and where they are connected)

E&W scenario



Commentary

FES Scenarios

Overall wind capacity increases in all FES scenarios over the period. While each scenario expects a modest growth in onshore wind (limited by local planning restrictions), the increases in wind capacity are predominantly driven by offshore wind.

As expected, given that the majority of offshore wind connects to the transmission network, the higher decarbonisation and lower decentralisation scenario (Two Degrees) has the highest expectation of offshore wind. This is then followed by the lower decarbonisation and lower decentralisation scenario (Steady Progression).

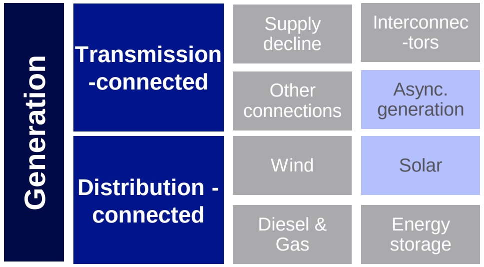
E&W scenario

The E&W scenario assumes a higher growth in overall wind capacity (driven by offshore wind) than any of the FES scenarios. This reflects:

- outcomes from the recent CFD auction;
- the ongoing reduction in costs (coupled with improving engineering solutions such as the size of turbines);
- more customers of the transmission network requesting for an earlier connection date; and
- the Crown Estate indicating leasing further potential sites.

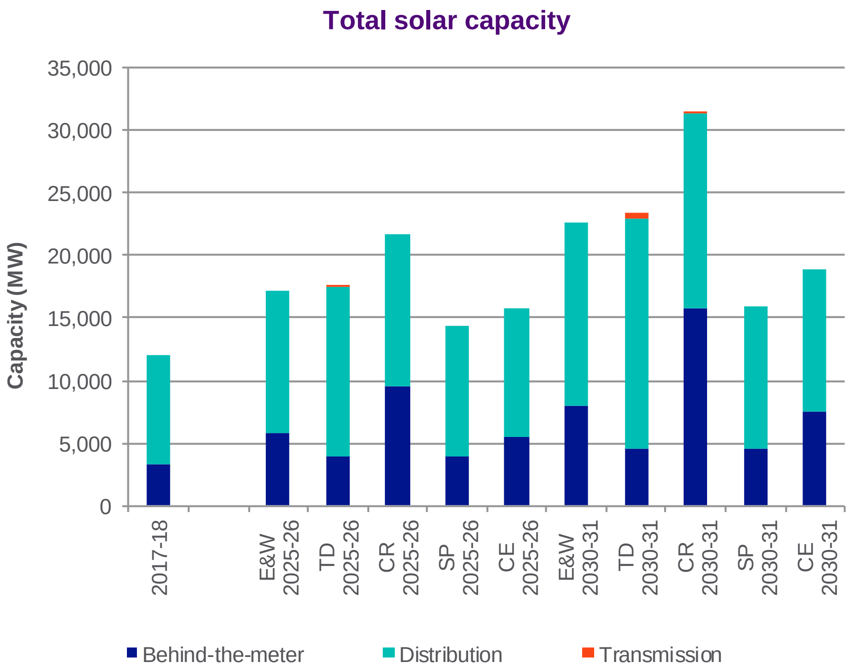
11. Installed solar capacity

Drivers of generation



- Variability in solar generation capacity will affect the need for transmission capacity
- There may also be an impact on voltage due to high concentration of solar capacity in the South of England

E&W scenario



Commentary

FES Scenarios

Overall solar capacity increases in all FES scenarios over the period.

The Community Renewables scenario, which reflects higher decarbonisation and higher decentralisation, expects the highest increase in solar capacity, driven by behind-the-meter solar.

This is then followed by the Two Degrees scenario, reflecting higher decarbonisation but lower decentralisation, with a greater amount of distribution-connected solar capacity plus a marginal addition of transmission-connected solar capacity.

E&W scenario

Overall, the E&W scenario is positioned in the middle of the FES scenario ranges. This increase, in line with the FES, reflects continued decreasing costs towards cost parity.

Additionally, the continued growth in solar capacity is likely to be driven by the combination with battery applications (as well as smart technology and time-of-use-tariffs).

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